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EXAMINER

VU, QUANG D

| ART UNIT | PAPER NUMBER |
|----------|--------------|
|----------|--------------|

2811

DATE MAILED: 04/23/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

| | | | |
|------------------------------|-----------------|--------------|--|
| Office Action Summary | Application No. | Applicant(s) | |
| | 09/652,550 | JONO ET AL. | |
| | Examiner | Art Unit | |
| | Quang D Vu | 2811 | |

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on amendment filed on 02/06/03.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-9, 11-32 and 62-68 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☒ Claim(s) 13, 16, 19-21 is/are allowed.
- 6) ☒ Claim(s) 1-9, 11-12, 22-24, 27-32, 62-68 is/are rejected.
- 7) ☒ Claim(s) 14, 15, 17, 18, 25, 26 is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) Paper No(s). _____ |
| 2) <input type="checkbox"/> Notice of Draftperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Claim Objections

Claim 12 is objected to because of the following informalities: In lines 1-2, the phrase "...forming a first isolation trench portion comprises forming a first isolation trench portion..." should be changed to "...forming said first isolation trench portion comprises forming said first isolation trench portion...". Appropriate correction is required.

Claim 14 is objected to because of the following informalities: In line 2, the phrase "...forming a first isolation trench portion having..." should be change to "...forming said first isolation trench portion having...". Appropriate correction is required.

Claim 15 is objected to because of the following informalities: In lines 1-2, the phrase "...forming a first isolation trench portion comprises forming a first isolation trench portion including..." should be change to "...forming said first isolation trench portion comprises forming said first isolation trench portion including...". Appropriate correction is required.

Claim 17 is objected to because of the following informalities: In lines 1-2, the phrase "...forming a first isolation trench portion comprises forming a first isolation trench portion having..." should be changed to "...forming said first isolation trench portion comprises forming said first isolation trench portion having...". Appropriate correction is required.

Claim 23 is objected to because of the following informalities: In lines 1-2, the phrase "...forming a first isolation trench portion comprises etching..." should be changed to "...forming said first isolation trench portion comprises etching...". Appropriate correction is required.

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Claim 27 is objected to because of the following informalities: In lines 1-2, the phrase "...forming a first isolation trench portion comprises forming a first isolation trench portion having..." should be changed to "...forming said first isolation trench portion comprises forming said first isolation trench portion having...". Appropriate correction is required.

Claim 32 is objected to because of the following informalities: In lines 1-2, the phrase "...forming a gate comprises forming a gate comprising polysilicon" should be changed to "...forming said gate comprises forming said gate comprising polysilicon". Appropriate correction is required.

Claim Rejections - 35 USC § 112

1. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

2. Claims 5-7, 9, 24 and 65-68 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claim 5, in lines 4-5, the phrase "forming a masking layer having an opening disposed therein atop the silicon nitride layer..." is unclear. The specification discloses a photoresist layer (38) having an opening disposed on the top of the silicon nitride layer (36) (a portion of the masking layer [32] in fig. 3). The specification never discloses a masking layer having an opening disposed on the top of the silicon nitride layer.

Claim 9, in lines 4-5, the phrase "forming a masking layer having an opening disposed therein atop the silicon nitride layer..." is unclear. The specification discloses a photoresist

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layer (38) having an opening disposed on the top of the silicon nitride layer (36) (a portion of the masking layer [32] in fig. 3). The specification never discloses a masking layer having an opening disposed on the top of the silicon nitride layer.

Claim 24, in lines 3-4, the phrase "...forming a masking layer having an opening disposed therein atop the silicon nitride layer, the opening including sidewalls" is unclear. The specification discloses a photoresist layer (38) having an opening disposed on the top of the silicon nitride layer (36) (a portion of the masking layer [32] in fig. 3). The specification never discloses a masking layer having an opening disposed on the top of the silicon nitride layer.

Claim 65, in lines 12-13, the phrase "...forming a masking layer having an opening disposed therein atop the silicon nitride layer, the opening including sidewalls" is unclear. The specification discloses a photoresist layer (38) having an opening disposed on the top of the silicon nitride layer (36) (a portion of the masking layer [32] in fig. 3). The specification never discloses a masking layer having an opening disposed on the top of the silicon nitride layer.

Claim 68, in lines 12-13, the phrase "...forming a masking layer having an opening disposed therein atop the silicon nitride layer, the opening including sidewalls" is unclear. The specification discloses a photoresist layer (38) having an opening disposed on the top of the silicon nitride layer (36) (a portion of the masking layer [32] in fig. 3). The specification never discloses a masking layer having an opening disposed on the top of the silicon nitride layer.

Claim Rejections - 35 USC § 102

3. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

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A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

4. Claims 1-4 and 12 are rejected under 35 U.S.C. 102(e) as being anticipated by US Patent No. 6,274,457 to Sakai et al.

Regarding claim 1, Sakai et al. (figures 7, 8a-d) teach a method of forming an isolation trench in a semiconductor comprising:

forming a first isolation trench portion (a trench portion that has an angle of A1) having a first depth and having a first sidewall intersecting a surface of the semiconductor at a first angle;

forming a second isolation trench portion (a trench portion that has an angle of A2) within and extending below the first isolation trench portion (a trench portion that has an angle of A1), the second isolation trench portion having a second depth and including a second sidewall intersecting the first sidewall at an angle with respect to the surface that is greater than the first angle; and

filling the first and second isolation trench portions with dielectric material (4) (column 9, line 25 – column 10, line 13).

Sakai et al. teach forming the first isolation trench portion (a trench portion that has an angle of A1) comprises forming the first isolation trench portion having a first depth about 3.75 to 37.5 percent of a total trench depth (see figures 8a-d; column 9, lines 42-63). Sakai et al. show the first isolation trench portion having a first depth of between five and fifty percent of a total trench depth.

Regarding claim 2, Sakai et al. disclose the second angle of the second trench of about 75 degrees to 90 degrees (column 9, lines 60-62). Therefore, Sakai et al. teach forming a second isolation trench portion includes forming the second angle to be between eighty and ninety degrees.

Regarding claim 3, Sakai et al. teach forming a first isolation trench portion includes forming the first angle to be in a range of from about thirty degrees to about seventy degrees (column 9, lines 44-46) and forming a second isolation trench portion includes forming the second angle to be more than eighty degrees (column 9, lines 60-62).

Regarding claim 4, Sakai et al. teach the semiconductor (1) comprises silicon (column 5, line 64).

Regarding claim 12, Sakai et al. teach forming the first isolation trench portion comprises forming the first isolation trench portion including a sidewall at least some of which forms a substantially straight linear segment.

Claim Rejections - 35 USC § 103

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

6. Claim 8 is rejected under 35 U.S.C. 103(a) as being unpatentable over Sakai et al. as applied to claim 1 above, and further in view of US Patent No. 6,258,688 to Tsai.

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Regarding claim 8, Sakai et al. (figures 7, 8a-d) differ from the claimed invention by not forming the first isolation trench portion comprises plasma etching the first isolation trench portion using gases including CF_4 and CHF_3 . However, Tsai teaches forming the isolation trench portion comprises plasma etching using compound gases of CF_4 and CHF_3 (column 5, lines 18-38). Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to incorporate the teaching of Tsai into the method taught by Sakai et al. because it reduces the size of the trench.

Neither Sakai et al. nor Tsai teach forming the first isolation trench portion comprises plasma etching the first isolation trench portion using gases including CF_4 and CHF_3 in a ratio of $\text{CF}_4/\text{CHF}_3 = 0.11$ to 0.67 . It would have been obvious to one having ordinary skill in the art at the time the invention was made to find the optimal ratio of the gases of CF_4 and CHF_3 , since it has been held that discovering the optimum or workable ranges involves only routine skill in the art. In re Aller, 105 USPQ 233.

7. Claim 11 rejected under 35 U.S.C. 103(a) as being unpatentable over Sakai et al. as applied to claim 1 above, and further in view of US Patent No. 5,874,317 to Stolmeijer.

Regarding claim 11, Sakai et al. differ from the claimed invention by not planarizing the dielectric material filling the first and second isolation trench portions. However, Stolmeijer teaches planarizing the surface of the insulating layer (see figure 22). Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to incorporate the teaching of Stolmeijer into the method taught by Sakai et al., since it reduces the size of the device.

8. Claims 22, 27-30, 32 and 62-64 are rejected under 35 U.S.C. 103(a) as being unpatentable over US Patent No. 5,969,393 to Noguchi. in view of US Patent No. 6,274,457 to Sakai et al.

Regarding claim 22, Noguchi (figures 2A-4B) teaches a method of forming an isolation trench isolated transistor comprising:

forming first and second trenches disposed to a respective side of a portion of silicon,
forming the first and second isolation trenches;

filling the first and second isolation trench portions with dielectric material (103);

forming a gate (108) extending across the silicon portion from the first isolation trench to the second isolation trench; and

forming source and drain regions (109) extending between the first and second isolation trench portions, the source region being disposed adjacent one side of the gate and the drain region being disposed adjacent another side of the gate that is opposed to the one side.

Noguchi differs from the claimed invention by not forming a mask on the surface, the mask including first and second openings corresponding to the first and second isolation trenches; forming a first isolation trench portion in each of the first and second openings, each first isolation trench portion having a first depth and having a first sidewall intersecting a surface of the semiconductor at a first angle; and forming a second isolation trench portion within and extending below each of the first isolation trench portions, the second isolation trench portions having a second depth and including a second sidewall intersecting a respective one of the first sidewalls at an angle with respect to the surface that is greater than the first angle. However, Sakai et al. teach forming a mask (column 9, line 42) on the surface, the mask including an

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opening corresponding to the isolation trench; forming a first isolation trench portion (a trench portion that has an angle of $A1$) in the opening, the first isolation trench portion having a first depth and having a first sidewall intersecting a surface of the semiconductor at a first angle; and forming a second isolation trench portion (a trench portion that has an angle of $A2$) within and extending below the first isolation trench portion (a trench portion that has an angle of $A1$), the second isolation trench portion (a trench portion that has an angle of $A2$) having a second depth and including a second sidewall intersecting the first sidewall at an angle with respect to the surface that is greater than the first angle (see figures 7, 8a-d; column 9, line 25 – column 10, line 13). Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to incorporate the trench-forming method of Sakai et al. into the first and second isolation trench-forming methods of Noguchi because it provides good electrical characteristics to the device isolation region.

Regarding claim 27, the combined device teaches forming a first isolation trench portion comprises forming a first isolation trench portion having a first sidewall intersecting a surface of the semiconductor at an angle in a range of from about thirty degrees to about seventy degrees (column 9, lines 44-46).

Regarding claim 28, the combined device teaches forming a first isolation trench portion comprises forming a first isolation trench portion including a side at least some of which forms a substantially straight linear segment (see figure 7 of Sakai et al.).

Regarding claim 29, the combined device teaches forming a second isolation trench portion comprises forming a second isolation trench portion having a second sidewall forming an angle of more than eighty degrees with the surface (column 9, lines 60-62).

Regarding claim 30, the combined device teaches forming the first isolation trench portion (a trench portion that has angle of A1) comprises forming the first isolation trench portion having a first depth about 3.75 to 37.5 percent of a total trench depth (see figures 8a-d; column 9, lines 34-63 of Sakai et al.). The combined device shows the first isolation trench portion having a first depth of between five and fifty percent of a total trench depth.

Regarding claim 32, the combined device teaches a gate comprising polysilicon ([108] of Noguchi).

Regarding claim 62, the combined device teaches the source region ([109] of Noguchi) is disposed adjacent only one side of the gate.

Regarding claim 63, the combined device teaches the drain region ([109] of Noguchi) is disposed adjacent only one side of the gate.

Regarding claim 64, the combined device teaches the source region and drain region are disposed directly opposite one another on opposite sides of the gate.

9. Claim 23 is rejected under 35 U.S.C. 103(a) as being unpatentable over Noguchi and Sakai et al. as applied to claim 22 above, and further in view of US Patent No. 6,258,688 to Tsai.

Regarding claim 23, the combined device teaches forming a first isolation trench portion (a trench portion that has an angle of A1) comprises etching the silicon surface. Noguchi and Sakai et al. differ from the claimed invention by not etching the silicon surface using gases including CF₄ and CHF₃ to form a first isolation trench portion. However, Tsai teaches forming the isolation trench portion comprises plasma etching using compound gases of CF₄ and CHF₃ (column 5, lines 18-38). Therefore, it would have been obvious to one having ordinary skill in

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the art at the time the invention was made to incorporate the teaching of Tsai into the method taught by Noguchi and Sakai et al. because it reduces the size of the trench.

Noguchi, Sakai et al. and Tsai differ further from the claimed invention by not forming the first isolation trench portion comprises plasma etching the silicon surface using gases including CF_4 and CHF_3 in a ratio of $\text{CF}_4/\text{CHF}_3 = 0.11$ to 0.67 . It would have been obvious to one having ordinary skill in the art at the time the invention was made to find the optimal ratio of the gases of CF_4 and CHF_3 , since it has been held that discovering the optimum or workable ranges involves only routine skill in the art. In re Aller, 105 USPQ 233.

10. Claim 31 is rejected under 35 U.S.C. 103(a) as being unpatentable over Noguchi and Sakai et al. as applied to claim 22 above, and further in view of US Patent No. 5,874,317 to Stolmeijer.

Regarding claim 31, Noguchi and Sakai et al. differ from the claimed invention by not planarizing the dielectric material filling the first and second isolation trench portions. However, Stolmeijer teaches planarizing the surface of the insulating layer (see figure 22). Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to incorporate the teaching of Stolmeijer into the method taught by Sakai et al., since it reduces the size of the device.

Allowable Subject Matter

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11. Claims 5-7 and 9 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.
12. Claims 25 and 26 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.
13. Claims 13, 16 and 19-21 are allowed.
14. The following is a statement of reasons for the indication of allowable subject matter: The most closely related art, US Patent No. 6,274,457 to Sakai et al. Sakai et al. do not anticipate or render the claimed invention such as forming a mask on the surface, the mask including an opening and sidewalls; and etching the silicon surface using gases including CF_4 and CHF_3 in a ratio of $\text{CF}_4/\text{CHF}_3 = 0.11$ to 0.67 to form a first isolation trench portion, wherein the etching forms the opening and sidewalls in the mask.

Response to Arguments

Applicant's arguments with respect to claims 1-4, 8, 11 and 12 have been considered but are moot in view of the new ground(s) of rejection.

It is argued, in page 22 of the remark, that Noguchi and Sakai et al. do not teach or suggest forming a mask on the surface, the mask including first and second openings corresponding to the first and second isolation trenches; forming a first isolation trench portion in each of the first and second openings, each first isolation trench portion having a first depth and having a first sidewall intersecting a surface of the semiconductor at a first angle; and forming a

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second isolation trench portion within and extending below each of the first isolation trench portions, the second isolation trench portions having a second depth and including a second sidewall intersecting a respective one of the first sidewalls at an angle with respect to the surface that is greater than the first angle. However, Sakai et al. teach forming a mask (column 9, line 42) on the surface, the mask including an opening corresponding to the isolation trench; forming a first isolation trench portion (a trench portion that has an angle of A1) in the opening, the first isolation trench portion having a first depth and having a first sidewall intersecting a surface of the semiconductor at a first angle; and forming a second isolation trench portion (a trench portion that has an angle of A2) within and extending below the first isolation trench portion (a trench portion that has an angle of A1), the second isolation trench portion (a trench portion that has an angle of A2) having a second depth and including a second sidewall intersecting the first sidewall at an angle with respect to the surface that is greater than the first angle (see figures 7, 8a-d; column 9, line 25 – column 10, line 13). Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to incorporate the trench-forming method of Sakai et al. into the first and second isolation trench-forming methods of Noguchi because it provides good electrical characteristics to the device isolation region.

The combined methods teach the methods of the claimed invention. The combined methods also teach the advantage for Noguchi to have ^{the} method of Sakai et al. Therefore, it is reasonable to combine Noguchi and Sakai et al.

Conclusion

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Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Quang D Vu whose telephone number is 703-305-3826. The examiner can normally be reached on Monday-Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Tom Thomas can be reached on 703-308-2772. The fax phone numbers for the organization where this application or proceeding is assigned are 703-308-7722 for regular communications and 703-308-7722 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.

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April 21, 2003

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STEVEN LOHE